MULTIDISCIPLINARITY IN COMPANY MANAGEMENT STUDIES

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Summary

The paper deals with the calculation of costs and outputs, with special regard to the optimization of production structure. The subject is a key point of corporate economics, being one of the main fields of industrial engineering studies. To have a scientifical basis for these calculations, the practical application of system-theory is proposed. The integration of standard and direct costing methods is proposed. For calculations serving planning, control, measurement and analysis, the latest results of applied informatics, decision theory, probability calculations, operations research and creative psychology should be applied. The trends in the field—showing the strengthening of multidisciplinarity, the integration of human-technical-economic aspects as well as the application of up-to-date communication networks—are outlined, too.

Since the formation of the industrial engineering type education, the educational institutions concerned all over the world have been striving to impart an interdisciplinary knowledge that prepares future engineers for the simultaneous consideration of technical, economic and human aspects. The disciplinary basis of these efforts has been well reflected in the well-known Industrial Engineering Handbook (1) by *H. B. Maynard* since it was first published, dealing e.g. with the formation of production systems, behavioural science, human factors, engineering, mathematical statistics, computers, cost analysis etc. We neither want to discuss the advantages, disadvantages and the expedient measure of specialization existing in the field of scientific research, education, engineering activities, and production, depending on a number of factors, nor to raise similar ideas as to the question of universality. Instead, we start from the fact, that—besides *the readiness and ability for teamwork*—depending on the characteristics of the task, in one case a specialist can get engrossed in a relatively narrow special field, in the other the one capable to solve the same problem in a creative manner applying the knowledge of several scientific fields.

As to industrial engineering, the (broad) sphere of problems is given. This is the successful operation of the company and within it that of production in a wider sense. Practical solution of the emerging part-problems can be solved by the ancient and new knowledge of numerous fields of science, with a dynamically

changing content and composition. The actual aggregate of knowledge is varying partly in its disciplinary elements and composition, partly in a way, that the new results of some scientific fields affect the content of others.

In above was mentioned all because for the sake of developing our industrial engineering-type education we want to study consciously *what composition of knowledge* contributes best to progress. From among characteristic topics of our department connected with management in the following,—seemingly evergreen—we selected a group of topics and/or limited ourselves to same, that has existed everywhere, since the very beginning of industrialization. It is the *economics of industrial companies and mainly the part dealing with cost and profit and/or performance.*

The connection of this group of topics with industrial engineering activity need not be proved, and it is a well-known fact, too, that pertaining research-work is in progress in numerous places. The title catalogue of literature on these topics makes up a volume. Thus, even with the best intention, there is a danger of provincial-type novelty-seeking, acceptable, to a certain measure only because the purpose-oriented entity of the aggregate is given, in the specific field of knowledge, by the combination of ever more knowledge elements. The change for relatively new combinations is growing hopefully with a considerable number of elements.

Specifications in the history of "costing"

If someone wishes to promote the process of cost planning and economic calculation by scientific research taking into consideration the main conditions and reasons forming the present situation—viz. accessing not only the present but also studying the history of "cost science"—he may face a lot of peculiarities.

Striking is not only the *simultaneous and long-lasting existence of different theories* but of such contradictions, too, that could have been cleared by mathematical methods very simply if the demands of knowing different ideas and their creative discussion had been a dominating force of development. On the one hand I mean the prime product cost calculation based on complete cost-division (to be discussed later), on the other hand the methods based on Direct costing (or the former term: Direct Cost Accounting System) have to be mentioned.

The connection between theories and practice is contradictory. One extreme is the double entry book-keeping system by *Lucas Paccioli* published five centuries ago, that has since stood the challenge of practice in cost and profit accounting.

The other extreme from the cost-functions described and instructed by many are *the so-called U-curves.* Looking at the effects of fixed costs it was found in our research activity during the sixties, that these curves—at least in a generalized way—could not be verified in practice. In this study entitled "Rational Decision Making in Business Organizations" [2] *H. A. Simon,* does not accept the U-curves based on empiric examinations only, but on theories originating from the presumption of restricted rationality, too.

It is interesting *to examine the interrelation of* both Direct costing and Standard costs procedures supporting company planning, operative management and control. According to many, the formation of the Standard Cost procedure is in a close connection with industrial engineering activity. Based on *F. W. Taylor's* work, engineers educated for a scientific analysis and planning of work processes and operations, transplanted their knowledge about work organization and standardizing—the technical standards—not only concerning wages, but also the entire sphere of cost, thus developing standard cost accounting. So, besides the aptly named "historical costing", cost planning and the measurement connected to it have more and more come into prominence, supported mainly by *G. Charter Harrison's* activity started as early as in 1911 but published only later [3].

The well-known purpose of standard cost-accounting is to hold in hand the company cost management as a whole, to plan and to measure and herring to the budget of all organizational units (mainly the workshops), to determine the deviations and mainly their causes and/or sources in the field of utilization of capacities, work intensity and cost standards.

This multiple procedure monitoring the operation of the organizational units and the suitable proportion of performances and inputs *gives more* than indicated by its none too lucky name. The surplus lies in the fact, *that it takes into consideration not only the important factors of the cost side, but many characteristics of the performance side too,* mainly as to the workshops. Besides this surplus, however, it is restricted in its contents regarding product costs and the attainable yields. That is why the companies have to apply other procedures as well. Among these Direct costing, elaborated by *J. Harris* and others at about the same time as standard cost accounting was, may be the first. The identity of name and contents is missing here as well, therefore other names have come up eg. Variable cost accounting, Marginal Costing (Lawrence, F. C.—Humphreys, E. N. [4]) in past decades, but referring to a wider utilization Control accounting, Responsibility accounting have come up as well. According to *W. Neidirk* [5] these names are based on *Harris's* fundamental thought:

"*Direct costing* is a cost dividing method, to differentiate between costs that are constant and proportional ones in direct connection with the amount of production and changing with same. Direct costing also serves to assess

stocks, by the direct (proportional) cost indicating the value of the manufactured finished and/or semi-product. Indirect costs manifest themselves as a loss diminishing profit. In the foreground of the process the determination of profit and/or loss is to be found." It is interesting that this definition is limited to only one of the denominative elements of the procedure, to the costs, though *its main characteristic is the difference resulting from the comparison between the proportional costs of products and the return of sales, determining the so called coverage.* Similarly, theories emphasizing the *limit-* or *differential* cost character of these costs are limited only to the proportional costs of products. These theories have not attained a relationship with the price i.e. the coverage. The recognition of this latter as a denominative factor has only taken place well after the birth of the direct costing procedure.

If we compare the main purposes (that have become more numerous increasing with time) of the standard and direct costing procedures, it is striking to what a large extent they complement each other. *Standard costing is strongly organization orientated* which is advantageous in many respects. The direct cost accounting can provide proper information on the one hand about *products* and on the other about *the company as a whole*, in addition it does not exclude, in principle, a substantial investigation of the costs of the organizational units.

The advantage of even a partial integration of the standard and direct procedures can be proved by the following two cases. For the upper management the economic performance of an individual organizational unit is interesting from the point of view how much it supports the output of the company. Let us suppose for example that measurements of the standard costing procedure show that the real utilization of capacities in plant "A" was 70% instead of the planned 80%, and therefore the unnecessarily reserved resources resulted in an X amount of essentially superflouos, indirect cost that ties up resources. This information cannot be regarded as uninteresting especially if the cause of the difference is known. It becomes even more interesting, if we are informed about the *sums of coverage* that signal *lost profit*. Depending on numerous specialities there are a lot of coverage calculation forms from the average coverage per machine-hour up to the alternatives belonging to the different product structure variants that take into consideration the effects of the bottle-neck feature of some resources.

The other example: At the mentioned company-level application of direct costing, when creating the well-known "base line" (Return of sales—direct costs = coverage, coverage – indirect cost = profit, in short the RCCP structure) it is not reasonable to start from the supposition that all costs except proportional cost are identical with the aggregate of indirect company costs. It is expedient however to base the planning and measurement of indirect costs on a calculations that make possible to enforce all advantages of standard costing *regarding each organizational units.* In the course of the calculation the

degressive feature of several costs and the unavoidable uncertainty in planning can be taken into consideration as well.

The above way of bringing together some elements of Standard and Direct costing shows the theoretical-attitude purpose, that *it is not advisable to deal only with costs, but, at the same time also with performance, profit and/or lost profit*, in other words, *a cost-sensitivity is not sufficient*, it is more useful to strive to keep an eye on the interrelations and to be oriented in this manner [6].

Practically at the same time with the two discussed procedures, a costing method originating from *Schmalenbach* developed in many European countries, that tried to realize a more accurate cognition of the standard product cost by dividing the overhead among the products. Its origin dates back *to the Ordonance de Commerce* (1673) and/or *Jacques Savary*. At that time there were often fraudulent bankruptcies making property disappear. They justified steps taken by the authorities, to elaborate a procedure that considered primarily the accurate valuation of stock and the relation to the balance. The title [7] of perhaps the best known work of Schmalenbach shows the strong interconnection between standard cost calculation and pricing policy. This special historical background has its effect at present, too, e.g. in the following fields: The valuation of the self-produced stocks on the basis of the invested costs has the same character and results in data that *cannot be used in dynamic calculations*. The enforcement of the cognition of the *entire* standard cost and the method applied, dividing the overhead, can lead to distorted data. Thus, if a company has produced partly material- and partly wage-intensive products, but the overhead was divided on the basis of direct wages, the procedure presents an unrealistic low standard cost for the products requiring more material and a high one for those requiring a higher wage. Contrasting these distorted standard cost values with the prices can result but in a distorted specific "product profit". To some extent due to these cirsumstances, some companies in connection with the oil-crisis literally "calculated themselves out" from the market and went bankrupt in the seventies [8]. Others applying computers and methods of operation research also slipped upon the difficulties of cost and profit costing. They wanted to determine the product-composition providing maximum profit by linear programming, they did not take the coverage amount of the product as coefficient of the target function but based on the mentioned, distorted specific "product profit", which is not a linear variable.

So we have come to one of the essential functions of the direct costing procedure and/or coverages: *Without applying them profit optimum calculation cannot be made with linear programming*. This statement does not want to prove the unrestricted reasonability of this computing method.

System-theoretical basis

Starting in the sixties, examining the possible alternatives to widen the effectivity of education we have been looking for an answer to the following question: How to avoid in practical and in reality very simple calculations—from the soundness of which, however, the success or the failure (or at least their measure) of a company may depend—as including the assumed, complete self-cost of products in dynamic calculations?

The first solution is easy: If we know the fault, then the right procedure has to be instructed instead of the wrong one. But this is not enough. It would be more advantageous to possess a theoretical basis and a practical test that prevent further faults. The practical test (and/or proof) can easily be solved by graphic representation. (Fig. 1)

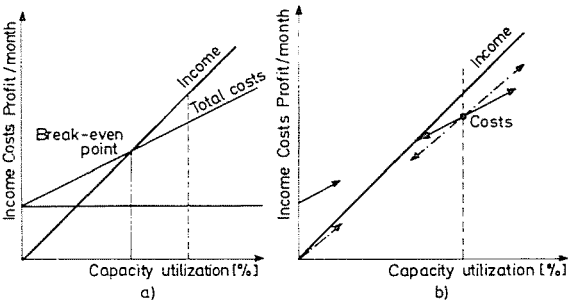

Fig. 1. Capacity and income, costs and profit functions

One of the most attractive advantages of the direct costing procedure is the fact, that supposing linear relations the RCCP (Return of Sales-Cost-Coverage-Profit) structure of the companies can easily be represented, and within a given interval of capacity-utilization the effects of changes can be quite accurately indicated (Fig. 1a).

By means of the procedure striving for total standard product cost cognition, we can represent only the momentarily valid point of the static cost data (Fig. 1b). To the question e.g. what direction the point of cost will move, the concept of the procedure inspires the answer: in direction of the origo (zero). This, however, is absurd, because it negates the existence of indirect costs. The other—right—answer would follow Fig. 1a, viz. direct costing. Some of the faulty orientations originating from the distribution of the total cost among the products could have been proved long ago with such a simple illustration. Graphic representation—unfamiliar to many—can supply preventive pro-

tection only in a narrow field. We can gain more by *utilizing system-theory* according to the following, schematic description:

We can regard the companies as systems, as an aggregate and such of resources, that can be characterized by two kinds of internal relations: The relations of the different resources belong to one of the relation-groups, the products of the resources and the system belong to the other. From the point of calculations, computing costs and profits primarily the second group of relations is determinant, though in many aspects the relation of resources has a similar character too. The survey of resources and products makes obvious, that some of the resources have a *deterministic*, others have a *stochastic connection* to the products, that *excludes identical procedures*, including the evaluation of the cost-product relations. The deterministic resource-product relations can be most easily described by a matrix:

$$\mathbf{A}x \leq b$$

where

- **A** is the matrix of coefficients showing the necessary use of resources for producing a unit product. Its general element: $a_{i,j}$
- **x** is a vector representing the aimed and optimal product structure. General element: x_j
- b is the value of the available resources for the plan period. General element: b_i

For practical purposes five types of relations have to be distinguished. The first and simplest is, when a product can be manufactured with only one kind of manufacturing resource (e.g. machine-line), when there is no possibility for conversion. In this case **A** is a diagonal matrix. The other extreme is the fifts type of relation, when many kinds of products can be manufactured with a varying use of different resources, there is no permanent bottle-neck but this depends on the given product composition. The types of relations characterized by convertability can be placed between these two extremes.

We find the advantage of a system-theoretical approach not only in the fact, that it is possible to make a hypothesis-based, mechanical cost distribution only when ignoring intentionally the disclosed logical, technical relations, but also, that this approach discloses calculatable factors influencing the right decisions that, even today, are not taken sufficiently into consideration in numerous companies. For instance, that determined *relations within a system*, for example the amount of the "realized" coverage (c = price − proportional cost) can be decisive as to what quantity should be manufactures or sold, or the "*manufacturing*" *coverage* $\left(\frac{c_i}{d_{ij}}\right)$ concerning a unit of bottle neck (e.g. machine-hour). One of the specialities of industrial engineering activity is the target-

oriented integration of information of the financial-economic and the production system, that, with the mode in the above example can be realized in many fields.

Integration of knowledge in several fields of science

To harmonize the human-economic-technical factors, we have introduced a curriculum instead of the previously thought business management, that starts with system-contemplation, and later, in harmony with Informatics, provides knowledge about applied company systematics. This basis—over and above our previous example modifies the contents of economics in many respects. Taking into consideration the information—communication networks of the future *more and more useful influences are developing* between the informatics and company systematics and economics. For example the *coverage/price* ratio is an important index both for product-developing and marketing experts. Marketing activity can be supported by a simple computer programme that examines the specific coverages of the product related to the RCCP structure of the company as shown in Fig. 2.

Products ICCP components [Ft/month]	A	B	C	D	E	Company's total	%
(I)	200	200	200	200	200	1000	100
(Cp)	200	160	130	70	40	600	60
(C)	0	40	70	130	160	400	40
(Cf)		–	–	–	–	300	30
(P)	–	–	–	–	–	100	10
coverage-solvency [%] c/p	0	20	35	65	80	$\frac{C}{I} =$	$=40$
$c/p \leq 0$	x						
$0 < c/p \leq \frac{C_f}{I}$		x				$\frac{C_f}{I} =$	$=30$
$C_f/I < c/p \leq C/I$			x				
$C/I < c/p$				x	x		
	It does not contribute to the coverage of the fixed cost	It contributes partly the coverage of the fixed cost	It makes profit but below the company average	Good products above the company average			

Fig. 2. Products characteristics

Though the scale of coverage-solvency of the products crystallizing in this way can provide valuable information, it is still valid that it cannot be only basis for decisions and in decisive situations it is necessary to apply the coverage of production instead of the realization coverages.

As shown in the paper by *K. Maczó* [9] each organizational unit presents its reflected image by means of standard cost accounting analysis. With the present technique the calculation is easy and also the results using CRT-terminals can be made known to many. It supports the realization and/or enforcement of mechanization of accounting, due since long in numerous companies. *In case of* economic calculations the system-theoretical approach can both prevent the utilization of stereotyped equations and support help to know with a decidable probability the expected effects of the planned intervention, for example technical development, investment, organization etc. The mentioned company RCCP structure may serve as a basis. With the help of a mixed composition team, the expected affected fields intervention, both quantifiables and non-quantifiables can be disclosed by means of creation-psychological innovation methods. Numerous empiric experiences prove that all quantifiable effects can be related to at least one component of the RCCP structure, so the effects on profits may be defined as well. Calculating the probable consequences of intervention variants such a way, the new RCCP structure is also provided as a by-product, calling attention to the fact, that the reaction capability of the firm may be changing. The mentioned method of revealing and evaluating different fields of impact might be useful even when using multivariant decision modell instead of the calculations based on RCCP structures.

It is not only in planning-type calculations, but also in realized output evaluations, that *the stochastic nature of relations, the probability of events, their risk and/or* insecurity should be taken into consideration. This way of thinking and of theoretical approach, which is a bit far from "historical accounting" and/or "costing", but influences, at the same time, the practical application of Direct and Standard costing. As a consequence, the linear RCCP structures according to Fig. 1. are sometimes substituted by "straited" structures with more than one break-even point. (Fig. 3)

In order to judge and stimulate the achievement of colleagues properly, it is reasonable to use tolerance-monitors, tolerance-ranges determined with mathematical-statistical methods when planning and measuring performance.

As, in many cases, it is necessary to take even the degree of cost-degressivity into consideration and measuring experiences, alone, are insufficient, it is necessary that e.g. also regression-analysis should become an integral part of cost-performance-informatics.

According to our exposition—which is far from complete certain of science, thus system-theory, theory of probability, mathematical statistics,

creation-psychology, informatics, decision theory, that—with the growing help of integrated information—communication networks—bring a fresh wind into the Life cost, yield and performance calculation, based since too long on its own, special material of knowledge [6]. This process of knowledge-integration

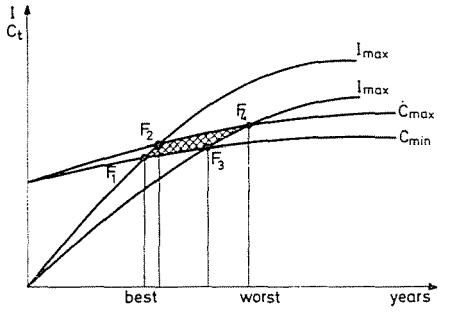

Fig. 3. Striped ICP structure

should constantly be under real practical control, to make up-to-date methods of economic calculations capable to become an organic part of company operation and the technical development process. In our opinion, however there is a precondition to the successful progress, viz. that the progressive elements of the three previously discussed, cost accounting procedures supplemented by earnings calculations should form an integral whole.

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